# The Role of Blockchain in Enterprise Procurement


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## Abstract

*Disruptive technologies, such as artificial intelligence, machine learning, or the blockchain, have the potential to transform entire industries as previous publications have outlined. They especially offer new opportunities to improve existing processes in the dimensions of performance, cost, and quality. Despite a continuously growing number of contributions, research and practice lack an adequate understanding about how blockchain can be used to achieve these benefits. Against this backdrop, this paper presents the current state of blockchain research in the field of enterprise procurement and outlines several avenues for future research. Therefore, we define relevant processes and functions to build a research framework for structuring and categorizing the current body of literature. Our results suggest that previous work mostly focuses on blockchain application scenarios with a focus on communication and transaction, while widely neglecting numerous fields, such as data integrity and data access.*


## 1. Introduction

In a global supply chain, the volume and duration of data, product and cash stream throughput has developed substantially over time. In particular the complexity for the coordination of actors and processes in the supply chain increased especially within the field of procurement due to the outsourcing of company expertise [1]. The finely meshed and opaque interweaving of participants causes coordination problems, which stem from information deficits or distortions between the shareholder [1]. Specifically, the information streams between the supply chain actors nowadays are not continuous due to the usage of central databases which results in a significant lack of transparency [2].

Blockchain technology could be the suitable solution for this problem. It has its origin in the work of Satoshi Nakamoto from 2008: "Bitcoin: A peer-to-peer electronic cash system" [3]. Originally conceived as an alternative to financial institutions for the transfer of money, the blockchain technology behind "bitcoin" has developed into a system with the potential to solve a variety of problems in modern data handling [4]. According to a survey of "Chain Business Insights", supply chain experts in 42 companies assess supply chain transparency (45.95 %) and transaction cost reduction (24.32 %) as the main advantages of blockchain technology for the supply chain [5]. Furthermore, IBM and Moller-Mearsk have recently announced a joint-venture to utilise blockchain in global trade [6]. Scientific research also shares this opinion and attributes great potential to blockchain technology in the supply chain [7], [8]. As shown, there is a growing interest for the potential of this new technology in one of the most crucial fields of economy and business, however it has not yet been analyzed to a sufficient degree.

For this reason, we would like to present the current state of research by using a well-structured literature analysis. Additionally, we aim to identify the potentials of blockchain technology within the supply chain environment. Moreover, our focus lays on the procurement processes because of their fundamental role in supply chain management as well as company success. Therefore, we summarize our research questions as follows:

> **RQ1:** What is the state of the art of blockchain research in procurement processes within a supply chain environment?
>
> **RQ2:** How can blockchain technology improve the quality of procurement processes in the supply chain?

We initiate this research by introducing related linked to the blockchain technology. In Section 3, we identify the main properties of procurement processes in supply chain management and derive a research classification framework. Subsequently, the framework serves as the basis for a detailed literature analysis in Section 5. Ultimately, we summarize the

URI: https://hdl.handle.net/10125/59895
ISBN: 978-0-9981331-2-6

insights obtained from the identified body of literature and present several avenues for future research.

## 2. Related work of blockchain research

The use of blockchain technology is discussed in various ways in the existing literature. Many theoretical concepts are presented [9] and some prototypical applications are developed [10]–[12]. However, most of the publications relate primarily to the use of financial transactions [7]. Risius and Spohrer (2017) conceptualize in their work the research process of science in relation to blockchain technology. The authors use the activity categories, concepts, measurement, and management as well as the analysis levels society, middlemen, platforms and industry. For each of the areas the respective sources are presented and finally the work presents research questions based on these areas [7]. Wiefling et al. (2017) present various applications of the blockchain which are not based on financial transactions. The authors introduce concepts to protect personal data, manage digital rights for media, improve the domain name service, store data to a community and finally monitor food production [13]. Hackius and Petersen (2017) describe four use cases of blockchain technology in logistics and supply chain management [14]. On the one hand, the blockchain can simplify paperwork and form transmission in logistic procedures. Furthermore, counterfeit products can be identified more efficiently and the traceability of the origin of a good can also be improved by the blockchain. And finally, they see the security of Internet of Things (IoT) devices in conjunction with the blockchain strengthened [14]. The presented works address the relation of the blockchain to the supply chain only marginally and deal rather with general applications.

However, there has not yet been a detailed investigation of how the blockchain can improve the quality of procurement processes. Furthermore, there is no overview of existing research of blockchain usage in the field of procurement.

## 3. Breaking down the supply chain and the blockchain

In order to be able to generate a thematic classification, the following chapter analyzes and prepares the different processes in supply chain management and different functions of the blockchain in a simplified way.

### 3.1. The supply chain processes

Each instance that influences the fulfilment of a customer order is part of a supply chain. Consequently, the involved parties are diverse and range from the manufacturer, through to the supplier to the dealer and ultimately to the customer [1]. Therefore, a structure of at least three organizations that are directly connected and/or traversed during the product flow is called a supply chain [15]. For such a supply chain it is recommended to optimize the cooperation of the parties in the cross-company processes and to take a process-related view of the network in order to improve the transfer of data [16].

The aim is to reduce costs and throughput times, increase product quality and enable more flexible handling [17], [18]. With a growing contingent of outsourced production goods, this goal can be achieved thanks to the influence of procurement on profit, end product quality and market position [16].

According to Porter's value chain model (1999), procurement, together with management, human resources and technology development, forms one of four main supporting activities in a company [19]. Its task is to supply products and services for their company's support functions, to select the best possible supplier and to monitor the orders placed [20], [21]. Its long-term objective is to secure the supply of production goods and to optimize the costs of supply in order to promote competitiveness. Procurement fulfils these goals by selecting suppliers, planning payment processes and planning deliveries [22]. From these tasks, three main procurement processes requiring interaction with the involved partners can be identified [23]:

- **Supplier management:** Identification and selection of suppliers. This process includes the search and selection of potential suppliers via information in the procurement markets. In addition, the analysis and inclusion of offers belong to the actions of this process [23], [24].
- **Contract management:** The process includes contract negotiation, ordering goods and the actual conclusion of the contract, including payment processing [23].
- **Logistics management:** This process deals with checking whether contractual provisions are complied with and organising the receipt of goods. Contract provisions include the time and material conditions. The monitoring of contract fulfilment, logistics, goods receipts and storage is also part of the logistiscs management [23].

### 3.2. The blockchain functions

Burgwinkel (2016) refers to blockchain technology as a technical concept, which, contrary to a central database, stores data distributed among users' systems using cryptographic methods [25]. As a decentralized, distributed, encrypted and immutable database it provides a public data ledger that enables transactions between two parties without a supervisory authority [26]. Digital addresses, so-called wallets with private and public keys [3], [27] are used to carry out these transactions. The blockchain serves as a distributed ledger in which the participants transactions are stored in blocks. Each block contains a time stamp and a reference to the previous block in addition to the transactions. The correspondent reference of the block to their predecessor leads to the creation of a chain of blocks, a "block chain". The blockchain is executed by the computers participating in the network, depending on the protocol of the blockchain used [11], [28], [29]. Various cryptographic procedures – so-called consensus mechanisms – are used to validate the blocks. For instance, proof-of-work and proof-of-stake methods are widely used here [3], [28], [30]. The access to the network itself varies depending on its configuration, which can be divided into three different settings: permissioned & private, permissioned & public and full public [12], [31]–[33]. Since a full public blockchain can be accessed by any computer, it provides strong encryption and a high degree of anonymity. In a private blockchain, on the other hand, the participants are known to each other, so that only authorized users can consult the data and a lower degree of anonymization is employed [29].

Core concepts can be derived from these definitions, which are ultimately transferred into three functions of the blockchain technology. According to Burgwinkel (2016), these three functions of blockchain technology are defined as:

- **Securing data integrity:** Blockchain technology allows us to prove whether database entries have been changed over time or not [25]. Since the entries are linked through hash values, any modification of the transactions in the block would lead to a change in the hash and therefore an invalidity of the block [27]. Once entered, data can only be changed at great expense (e.g. 51% attack) [3], [34].
- **Communication and transaction processing:** Transactions between participants can be performed via the blockchain [25]. The entry of a transaction and its validation constitute the groundwork for changes in the blockchains registry, the distributed ledger [27].
- **Data access and registration:** Blockchain technology enables controlled and transparent access to data in the interests of authors and owners [25]. Data access is monitored using time stamps, private keys and public keys [27].

## 4. Research process

After reviewing the related work in the field of blockchain applications, a detailed literature analysis was necessary to answer the research question and identify current topics of blockchain research in the supply chain. A structured approach, with regard to the documentation of the analytical framework, is essential to ensure the traceability of the carried-out analysis for a literature review. For the current literature analysis, we followed the guidelines of vom Brocke et al. (2009). Vom Brocke et al. (2009) and Webster and Watson (2002) recommend the usage of a concept matrix to subdivide topic-related concepts into different units of analysis [35], [36]. Since an unstructured concept matrix would provide very confusing results for our research questions we decided to develop a research classification framework to structure the results of the literature analysis.

**Table 1. Research classification framework**

| | | **Blockchain features** | | | **Reviews** |
|---|---|---|---|---|---|
| | | Data Integrity | Communication and transactions | Data access and registry | |
| **Supply processes** | Supplier management | | | | |
| | Contract management | | | | |
| | Logistic management | | | | |

A systematic literature classification in the concept matrix requires various content criteria which are to be applied to the compiled sources. The criteria are the reference to blockchain technology functions and the handling of procurement processes in the sources.

These criteria imply the actual discussion and/or presentation of such processes in relation to blockchain functions in the paper. The mere reference to these processes or functions is thus not considered a qualified criterion for acceptance within our literature research. Certainly, this leads to a strict filtering of sources on the one hand, but it also promotes a profound quality and relevance of the proposed work on the other. Due to the hyped status of this topic (especially supply chain applications) we decided to only promote qualified papers in favor of our focus on procurement processes and blockchain research development.

In an additional column those sources are listed, which are classified as literature review in the presented criteria. Our framework is based on the identified supply processes and blockchain functions in chapter 3 and shown in Table 1.

After defining a suitable research classification framework, we were able to start the literature analysis itself which is presented in the following chapter.

For an initial list of publications, we used a keyword search on the leading IS journals, namely the Senior Scholars Basket of Journals. Using those high quality IS journals would improve the quality of our own research through the rigor of the review process and the experienced editorial board. The initial literature search within the Basket was unsuccessful because the available amount of suitable publications is too small to be considered as representative. For this reason, the search was extended to more extensive scientific databases. However, attention was still paid to the high scientific quality of the selected contributions.

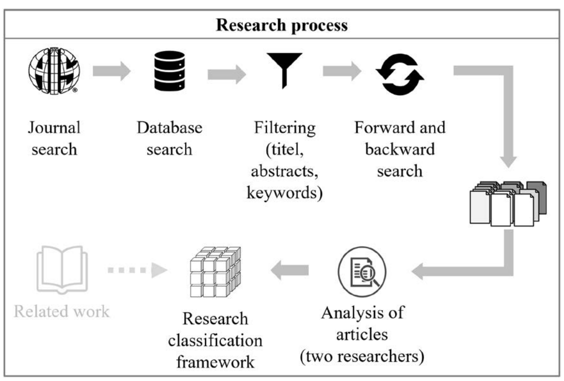


**Figure 1. The literature research process**

Following Risius and Spohrer (2017) (identified within the Senior Scholars Basket of Journals), the databases Science Direct, Springer Link and IEEE Xplore and were used for additional literature search (see Figure 1). In order to avoid a European focus, the Wiley Online Library was also used. For this purpose, the bibliographies are systematically queried using a defined search syntax. In order to exclude irrelevant results, a query for "Keywords", "Title" and "Abstract" is performed instead of the full text search. In order to obtain relevant results despite this limitation, sources containing the terms "Blockchain" and "Supply" or "Procurement" are considered. The system deliberately does not search explicitly for "Supply Chain", since this would, for example, exclude the term "Supply Management" from the query while it is intended to record all procurement-related sources.

Furthermore, we deliberately followed Risius and Spohrer (2017) and excluded the term “Distributed Ledger” from our research-syntax, as it is understood as a broad reference for technology with a peer-to-peer character, especially in the Fintech industry [7]. In contrary, we seek to precisely analyze blockchain-technology in the field of supply chain within a focus on enterprise procurement.

After a first database query, the above-mentioned literature collections yielded 449 articles. This result was further filtered according to content relevance by an abstract-, title-, and keyword analysis, as well as a strict distinction between shallow topic mentions and profound discussion of the relevant field. Additionally, we sorted out papers not explicitly discussing supply chain nor procurement, such as for example: fintech, health, terminologies or governmental issues.

**Table 2. Results of the literature research**

| Database | Results | Filtered results |
|---|---|---|
| Science Direct | 88 | 3 |
| Springer Link | 12 | 5 |
| IEEE Xplore | 174 | 6 |
| Wiley Online Library | 63 | 1 |
| **Total results ∑** | **449** | **15** |

We also performed a limited forward- and backward search for the confirmed articles to identify additional high-quality articles, as recommended by Webster and Watson (2002) [36]. This enabled us to add four more relevant articles to our literature analysis. A total of 19 articles were available for review, as the filtering excluded a significant amount of paper shallowly mentioning blockchain technology in supply chains and procurement.

**Table 3. Classified research results**

| | | **Blockchain features** | | | **Reviews** |
|---|---|---|---|---|---|
| | | Data integrity | Communication and transactions | Data access and registry | |
| **Supply processes** | Supplier management | *Lu und Xu (2017)* | *Chen et al. (2017); Weber et al. (2016)* | *Xu et al. (2017)* | *Risius and Spohrer (2017); Wiefling et al. (2017)* |
| | Contract management | *Foerstl et al. (2017)* | *Gallay et al. (2017); Morabito (2017); Nakasumi (2017); Nicoletti (2018)* | *O'Leary (2017)* | |
| | Logistic management | *Kshetri (2017); Li et al. (2017); Tian (2016)* | *Christidis and Devetsikiotis (2016); Hackius and Petersen (2017); Hofmann et al. (2018)* | *Kshetri (2018)* | |

After a detailed content evaluation, we classified the results of the literature analysis as shown in Table 3 using our research classification framework which was developed in chapter 4.

As we can see in table 3 almost 50 % of all articles broach the blockchains' communication and transaction function, which may be due to the initial solution presented by Nakamoto (2008) [3]. In particular, logistics management is in the focus of procurement processes by little over 40% of the available research results. This fact emphasises the earlier stated increase of interest in logistic related fields for blockchain applications. The process of supplier selection with four sources, as well as the registration and data access function (three sources) are seemingly underrepresented in the state of current research.

## 6. Research results

In the following, the results of our literature research will be presented classified into blockchain features broken down into the supply processes.

### 6.1. Data integrity

In order to fulfil the tasks of procurement, the exchange of reliable data is necessary for the precise cooperation of companies [1]. At present, the exact transmission of information between the participants suffers from data storage issues and a lack of information sharing. As a result, the information provided may be incomplete or modified. This leads to high communication costs, possible distortions, and diminished transparency [37]. The blockchain can guarantee the integrity of data [25] and may thus be a potential solution for this problem. Data can be stored on the blockchain, whereby two concepts are distinguished due to limitations on the size of the data set [38]. Again, it is possible to outsource the extensive data records and to store the hash value in the blockchain as a reference to the outsourced data [25]. Integrity verification is performed via the Merkle root, which summarizes all transactions in the block as a 256-bit note. The hash value of two transactions in the block is calculated as a double hash function. This process is repeated until only one single hash value remains, the Merkle root, which represents the end of the Merkle tree. The modification of a transaction would lead to a change in the Merkle root: the proof of integrity can thus be provided retroactively [27].

***Supplier management.*** To determine suitable suppliers, criteria are necessary which describe the requirements regarding quality, price and delivery date that apply to the suppliers [15], [21]. Quality data is stored in so-called "traceability systems", which serve to track products and are maintained by providers who store the data in central databases. With "OriginChain" Lu and Xu (2017) present a blockchain system which enables transparent, decentralized, and tamper-proof product tracking [10]. The aim is to provide a trustworthy tracking platform for laboratories, suppliers and customers to facilitate sustainable trading relationships. However, the system does not store all data on the blockchain but differentiates based on the memory limit. On-chain, only hashes of certificates as well as lot numbers, place of origin and examination date are stored. Certificates, images and addresses are saved in a central database. Deterministic smart contracts are used to execute these functions. When the sourcing company places an order at a supplier after reviewing the selection criteria, a standardized smart contract is generated with the tracking service provider. The contract examines the agreements of the parties and is partly authorized to apply changes [10].

***Contract management.*** Cost reductions can be achieved through efficient contract negotiation and better process control [15]. Weber et al. (2016) present a concept which intends to automate the monitoring of process execution and contract implementation with blockchain technology without the involvement of third parties [39]. The authors explain their solution using the scenario of a faulty delivery and a subsequent conflict between the contracting parties. This includes a smart contract as a control unit, which operates as an automatic and immutable transaction memory. Furthermore, smart contracts are used as communication coordinators, so that the participants do not need to interact directly with one another during the process: instead, they adress the smart contract. It stores the execution status of all participants by monitoring their message exchange and using the immutable data storage to record process protocols [39].

***Logistic management.*** In procurement, supervising the fulfilment of contract conditions results in real-time monitoring of delivery processes [23]. To cope with the complexity in the supply chain, the use of sensors and radio frequency technology for identification (RFID) is therefore used to interconnect and track the flow of materials and information [40]. In his paper, Kshetri (2017) deals with the potential of ensuring data protection in the supply chain and the Internet of Things , using the blockchain [41]. Encryption enables IoT devices to communicate securely with each other, thus ensuring a prompt and trustworthy verification of the materials. The ability of the blockchain to provide an immutable inventory book enables products and materials to be traced back to their origin through the network [41]. Tian (2016) also discusses this topic in his work and examines how the combination of RFID and blockchain technology can contribute to increase efficiency and transparency in the Chinese food market [42]. It is applied to guarantee the authenticity of published data. The author argues that, compared to a decentralized database, centralized data storages are susceptible to corruption, fraud and information falsification because of their monopolistic, asymmetric and opaque information system architecture. He also emphasizes that complete information of all supply chain participants leads to a healthier market environment [42].

Li et al. (2017) differentiate the data stored on the blockchain by its significance in the supply chain [43]. Shipment information and stock location are documented on a private blockchain ledger. A semi-public ledger is used to determine the location of specific goods while only external service providers are allowed to provide information on the goods condition. The contractual partners, customers and suppliers may only view data in the semi-public ledger, but not alter it [43].

## 6.2. Communication and transactions

Language barriers, currency risks, payment modalities and complex freight documents slow workflows and result in an increase in process and transaction costs [44]. With the publication of Nakamoto (2008) the most prominent application of the blockchain for communication and transaction processing was presented [3]. It allows sending money digitally without the need for financial service providers, directly and with very low transaction fees. Consequently, it is used to handle payment processes and communication data efficiently [25]. Morabito (2017) identifies possible applications of smart contracts in inter-company collaboration, such as querying delivery punctuality, budget compliance or other quantifiable values of suppliers [29]. Furthermore, a smart contract could automatically execute payments for incoming goods or fulfilment of conditions and thus bring considerable cost savings [29].

***Supplier management.*** To determine the suppliers, information about their costs and services are required [15]. In this process, Chen et al. (2017) identify three problems regarding the exchange of information with suppliers due to central systems [45]. The self-interest of the participants hinders the cooperation, central databases cause high information asymmetry in the production process and finally the quality control based on distrust causes further costs. To resolve this asymmetry, quality information, logistics information and transaction information is stored on the blockchain. The data sets are accessible to all participants and communicated without media discontinuity, whereby smart contracts are used for identity organization and data collection [45].

***Contract management.*** Manufacturers encounter the problem that they don't have immediate customer sales information and therefore quantity changes in earlier stages of the chain cannot provide information about changes in demand [24], [46]. Nakasumi (2017) identifies this problem as information asymmetry between the partners and presents a modified form of blockchain transactions to simplify data exchange [2]. The transmission of information is accomplished in such a way that product and order information is sequentially passed on from participant to participant and additionally interpreted and changed [2]. The information exchange is currently managed by an independent third party (e.g. software company), which leads to high transaction costs. In contrast, blockchain technology uses cryptographic methods to validate transactions, thereby reducing transaction costs and increasing data security, without the support of intermediaries [2]. The solution suggests a change in the transaction structure of the blockchain. The new form uses homomorphic encryption and thus enables further analytical processing of encrypted data without revealing its content. Furthermore, a "compound identity" is used, which can be used by several participants.

In the modified form, transactions are provided with an ID number, a product ID, product code and product number [2]. Apart from that sender, quantity as well as recipient are encrypted and therefore not visible to outsiders. In the metadata, conditions and actions are defined which invariably record and enforce these transaction requirements [2]. This approach is similar to the smart contracts approach, with the difference that the transaction is bound to a condition and only triggered on one side.

In contrast, Nicoletti (2018) states that smart contracts automatically trigger payment upon fulfilment of contract terms, eliminating the need for human interaction to execute payments and actual value transfer [47]. The smart contract is programmed so that it knows its own value and status. The moment of payment and the triggering condition are pre-programmed [47].

***Logistic management.*** Hackius and Petersen (2017) present projects of IBM and Mearsk, which use the blockchain to reduce the paperwork involved in transmitting consignment information and also enable fast tracking of goods [14]. Hofmann et al. (2018)

identify the supply chain stages of order processing, billing, payment and shipping as potential application areas for blockchain technology and smart contracts. With digital identification methods and sensor technology, the transmission of physical goods can be mapped on a blockchain [48]. Christidis and Devetsikiotis (2016) investigate the use of blockchains and smart contracts for the IoT [49]. A container leaves the manufacturer “A” and is to be transported to buyer “E“ by suppliers. In this scenario, the five participants use a common blockchain. They are connected to each other through a smart contract that stores the addresses of all participants [49]. A participant has the "I have the container" coin (H) if he is in physical possession of the container. During the transfer, (H), which is located at the public key of the owner, is transferred to the public key of the recipient. The (H) coin leaves a trace through its continuous transmission, which can be traced by looking at the transactions with the public keys of the participants [49]. Procurement logistics benefit from the blockchain by making product tracking and goods transfer more efficient and paperless. With the help of smart contracts and IoT sensors, the flow of goods can be documented transparently for all parties involved.

## 6.3. Data access and registry

The dissemination of data with information systems enables timely access and is necessary to coordinate the supply chain [37]. The problem is that data security, control over unauthorized data transfer and protection against cyber-attacks have not yet been sufficiently guaranteed despite trust in the partners [50].

***Supplier management.*** Every company uses its own Supply Chain Management (SCM) system. This makes integration into a coherent platform more difficult, as no continuous and uniform flow of information is created due to the different systems [24], [51]. "CoC (supply Chain On blockChain)" is a decentralized and cross-company SCM-system, which solves the problem of low performance and control over data access in a blockchain with a new storage scheme [51]. Ordinary users (manufacturers, procurers, suppliers) can add relevant supply chain information to the database. The third-party user (government, insurance companies) mainly controls the activities on the platform and supporting entities (financial institutions) have access by offering services [51]. To ensure increased access protection, the system distinguishes between the authorization to make entries and the authorization to form blocks. The second can only be performed by so-called helpers. However, the benefits of "helpers" for providing computing power are not described in detail and are therefore questionable without financial compensation.

***Contract management.*** The blockchain as a ledger in a supply chain could make data exchange and insight more efficient. O'Leary (2017) discusses which forms of the blockchain are advantageous for transaction processing in a supply chain [38]. He distinguishes between the public blockchain, the blockchain in a single company, the corporate use of blockchains in pairs and finally the application of a private blockchain in a consortium [38].

The freely accessible public blockchain completely eliminates the asymmetry of information between the participants. However, absolute visibility means that the competition may benefit from information insight and that scalability becomes problematic due to the growing amount of information and the energy consumption for validation [38].

The private blockchain is to be used for transaction storage in a single company. This means that all entries are made by the company and therefore the accuracy of the data is not automatically guaranteed. This implementation does not correspond to the conceptual idea of blockchain technology, which is based on mutual verification. Therefore, the author classifies this form of blockchain as impracticable [38].

The corporate blockchain in pairs makes sense if companies outsource a substantial part of their value creation or if there is a profound integration to another company. However, if the blockchain is only used for a certain subset of transactions, information bridges must be built between the blockchain and other enterprise systems, which results in conversion costs [38].

The consortium approach considers companies in a blockchain which also operate in a coherent supply chain. A defined type of information is exchanged between actors, such as orders or payments. In order not to endanger the competitive advantage by passing on information, the blockchains access control may only allow a certain insight. The author states that the blockchain consortium provides the most realistic application in the business environment [38].

***Logistic management.*** Kshetri (2018) examines how blockchain technology can contribute to the achievement of SCM goals [41]. In the case of logistic management, these goals are risk mitigation, cost reduction and rapidity. Since only mutually recognized participants can carry out transactions on the Private Blockchain, the risk of falsified quality and delivery information is diminished. Digitization of the physical process can further reduce interaction and communication costs in goods acceptance and document transmission using automated document validation [41].

## 7. Conclusion and future research

At the beginning of this paper, the supply chain, the procurement processes, and the blockchain technology were defined to introduce the topic. Subsequently, literature on the subject was systematically collected following the concept of vom Brocke et al. (2009) [35]. The results of the drilldown were then assigned to the subject areas of blockchain features and procurement processes in a research classification framework.

With reference to research question 1 presented in chapter 1, the evaluation shows that communication and transaction functions of blockchain technology together with contract and logistics management are the main focus of previous research. The process of supplier management and the data access and registry function of blockchain were the least discussed.

In order to answer research question 2, the identified literature was then analyzed in more detail and the core subjects were presented in chapter 6. The evaluation of the delivered results shows that blockchain has the potential to bring transparency and reliability to the data exchange of business partners. The blockchain and especially smart contracts can be used to document and coordinate process and document flows in a supply chain. Furthermore, tracking the origin of goods is made easier by smart contracts automating the flow of information and payments. Procurement logistics benefits from an increase in efficiency in receiving goods and an improvement in the cross-company documentation of physical goods flows thanks to the use of predefined intelligent electronic contracts. In order to secure data access in a decentralized database, it is proposed to use a consortium blockchain for a use case in a supply chain, as this is the only way to achieve control and data security.

Based on Nakasumi (2017), information flows could be mapped to the material flow in a decentralized database as shown in Figure 2 [2]. The information flow is marked with (a). The communication of the corporate software via the common blockchain is marked with (b). The material moves from the supplier via the manufacturer to the wholesaler. In (a), communication and transactions between supply chain actors are sequential. When using blockchain technology, participants would exchange information as shown in (b). The data is stored in a decentral way and is accessible to all parties involved. Therefore, blockchain technology facilitates the use of a common database for all supply chain stakeholders. The continuous information flow from (and towards) a decentralized and permissioned blockchain database (b) minimizes data distortion and additionally supports trust between the participants. Issues, that we previously identified as major problem of procurement and supply processes. This ultimately promotes transparency and consistent data resulting in reduced cost for cross-company interaction. Procurement processes such as contract management and logistics management directly benefit from this informational uniformity and availability.

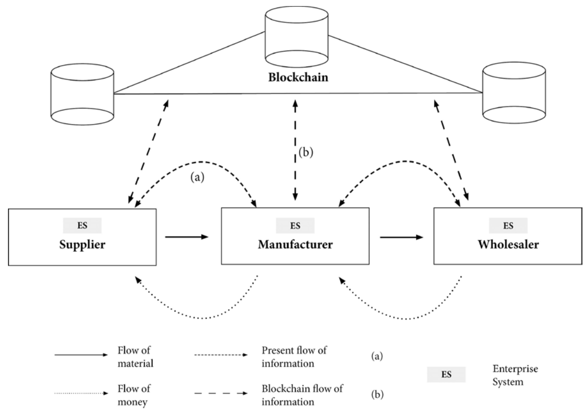


**Figure 2. Information flow in a supply chain with blockchain**

Following our insights, we state that research should focus on conceptual guidelines for the implementation of a blockchain and further research in the use of blockchain technology regarding material flow monitoring and contract management.

In summary, the findings of Risius and Spohrer (2017) and Korpela et al. (2017) confirmed that blockchain technology has great potential, especially in supply chain processes [7], [8]. Our literature analysis has shown that the functionalities of data integrity and data access and registry in particular have not yet been sufficiently explored.

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